

Final report, Joint Fire Science Program, 01-1-3-40

Project Title: Incorporating Spatial Heterogeneity into Fire Restoration Plans.

Project Location: Fire and Fire Surrogates Plots, Sequoia National Park, Southern Sierra Nevada, CA.

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Project Overview:

The goal of this project was to determine the relationship between heterogeneity in fire intensity and understory plant diversity after prescribed fire in Sequoia National Park. This study addressed four objectives: (1) to explore whether individual understory forest species are more likely to occur in spots that burned under high, moderate, or low intensity fire; (2) to determine to what extent prescribed fires through heavy, homogeneous fuels can generate the environmental heterogeneity important to maintaining plant diversity; and (3) to identify the factors that explain fine-scale variability in fire intensity; and (4) to compare two management options, early- and late-season prescribed fire, for their impact on environmental heterogeneity and understory plant community composition.

Summary of Key Findings:

- Species vary in their levels of tolerance to fire temperature such that different species are found after fire in sites that burned with high intensity versus sites that burned under low intensity fire.
- Prescribed fire creates environmental heterogeneity, which contributes to post-fire species diversity.
- Spatial heterogeneity in fire effects can be generated from any one of the following: patchy fuels, heterogeneous topography, or a spotty ignition pattern.
 - Patchy fuels occur when surface fuels are discontinuous OR when a continuous fuel bed of light fuels is periodically intersected with logs or other heavy fuels that burn at high temperatures and change fire behavior.
 - Heterogeneous topography occurs when a fire burns across areas with varying levels of fuel moisture (eg a network of ridges and drainages), solar radiation (eg different slope aspects), or slope steepness.
 - Ignition pattern can vary from systematic strip ignitions, which help ensure that every patch of surface fuel is ignited, to spot ignitions, which are more likely to leave patches of fuel unburned. Additionally, managers can manipulate ignitions to control which areas in a unit should burn at a particular time of day. (Burning a slope with heavy, continuous needle litter in the morning when humidity is high, for example, could result in a patchier burn than that same slope ignited in the afternoon.)

- Even systematically ignited prescribed fires can exhibit remarkable variability in fire temperature.

Management implications:

We have shown the importance of fine-scale variability in fire intensity on understory plant communities of a mixed-conifer forest in the Sierra Nevada, CA. Our research emphasizes the value of treating fire and fire effects in terms of continuous variables, rather than as a binary (burned/unburned). In addition to depending on a patchy pattern of fire intensity, biodiversity responds in other ways to the varied and complex effects of fire regimes, including the distribution of patch ages on the landscape, spatial patterns of fire intensity, burn pattern, and fire size, and landscape heterogeneity in burn probability. By making the effort to recreate a more heterogeneous fire regime, we can create complex mosaics of burn pattern where a variety of species coexist. Where the management objective is to mimic a pre-European settlement environment, or to preserve a diverse community of coexisting plant and animal species, then a better understanding of species responses to fire, and an increased recognition of the importance of spatial heterogeneity in management, will be required.

Deliverables:

Proposed	Delivered	Status
Annual Reports	2002, 2003, 2004	done
Dissertation	<u>Spatial considerations in fire management: the importance of heterogeneity for maintaining diversity in a mixed-conifer forest</u> , by Monique E. Rocca, 2004.	done
Posters	Spatial variability in fire effects: causes and consequences at multiple scales. Presented at the Sierra Nevada Science Symposium, Kings Beach, CA, October 2002. Spatial heterogeneity in fire intensity: causes and consequences for plant diversity. Presented at the 89 th Annual Meeting of the Ecological Society of America, Portland, OR, August 2004.	done
Presentations	Patterns of diversity with restoration of fire in the Sierra Nevada: evaluating the effects of fine-scale heterogeneity with wavelets. Presented at the Annual Meeting of the International Association of Landscape Ecology, Lincoln, NE, April 2002. Spatial considerations in fire management: the importance of heterogeneity for maintaining diversity in a mixed-	done

	<p>conifer forest. Presented at the Fire and Fire Surrogates Sequoia symposium, Sequoia National Park, CA, August 2002.</p> <p>Spatial heterogeneity in fire temperature: causes and consequences for plant diversity. Presented at the 2nd International Wildland Fire Ecology and Fire Management Congress, Orlando, FL, November 2003.</p> <p>Incorporating spatial heterogeneity into fire restoration plans. Presented at the Joint Fire Sciences PI Workshop, Phoenix, AZ, April 2004.</p>	
Publications	Four papers derived from the chapters of Monique Rocca's dissertation are in various stages of revision and review.	in progress